Radiology Corner Case # 42

Gun Shot to Thorax Resulting in Localized Hemothorax and Lung Contusion

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Note: This is the full text version of the radiology corner question published in the November 2009 issue, with the abbreviated answer in the December 2009 issue.

The authors present a case that highlights some important basic points about Chest X-Ray (CXR) interpretation. In addition, CT findings of a gunshot wound (GSW) to the thorax are highlighted to illustrate these findings to help drive home the teaching points. The chest x-ray is the most commonly ordered imaging study in combat hospitals; not dissimilar to civilian emergency rooms. In addition, this case highlights use of the CT scout in a hemodynamically stable casualty that can substitute for a CXR to maximize technologist resources, get casualties into CT without waiting for the portable CXR while saving valuable time in a surge of casualties.

Introduction

A pleural cap is a collection of fluid at the apex of the hemithorax seen in imaging studying with the patient lying on their back. Trauma to the great vessels of the mediastinum is a simple mechanism that can cause a pleural cap.

In US military experience in the 20th century, chest injuries account for 15% of war injuries, with 10% of chest injuries being superficial and requiring only basic wound management. The remaining chest injuries in war are virtually all penetrating. (1)

In recent US experience in Iraq and Afghanistan 6% of wounds involved the thorax. In World War II and Vietnam 13% of injuries were to the chest. Body Armor is a likely explanation for this decrease in wounds to the thorax. (2)

This decrease in thoracic wounds is welcome but the need for providers to rapidly evaluate penetrating injuries to the chest remains. The chest x-ray is the most rapid and accurate way to accomplish this. In times of surges or mass casualties where technologist resources become limited to obtain portable CXR's fast enough, in our experiences, the CT scout can be a force multiplier by providing essentially the same information a portable chest x-ray can provide. The CT study used in this case provides additional information to illustrate the use of the conventional chest radiograph.

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History

A 34 old soldier suffered a GSW to left thorax. A CT scout substituted for the chest X-ray due to an influx of other casualties in our combat hospital at that time, CT scout of chest, CTA of thorax, and CT para-axial reformats were obtained and presented for review.

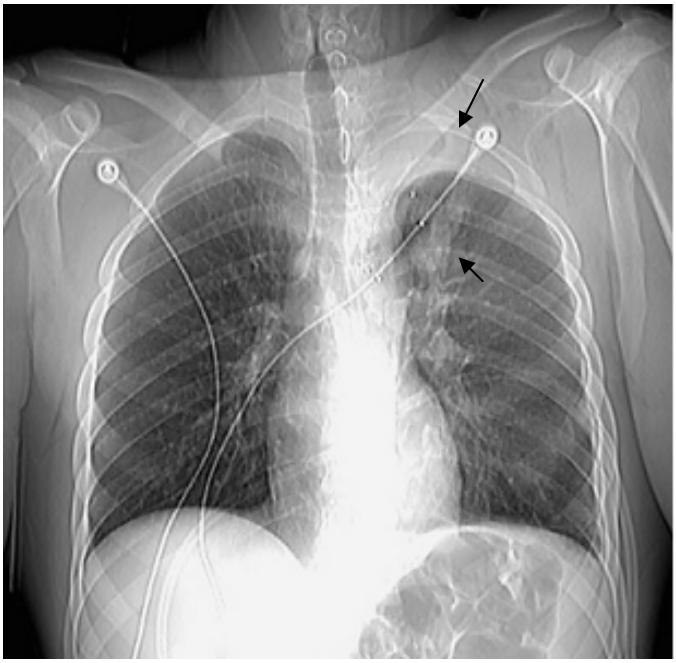

Figure 1, Scout CT substitute for chest radiograph demonstrates obliteration of normal left subclavian stripe and thickening of the left apical region consistent with localized hemothorax from GSW to the left chest (larger arrow). Some overall haziness to the left thorax is from superimposing hemothorax and decreased overall volume of left lung. There are some retained fragments, localized consolidation from the wound path (smaller arrow) in the perforating injury (entrance anterior, exit posterior).

Summary of Imaging Findings

The scout CT can at times serve as a substitute for chest radiograph during surges (mini-mass-casualties) of patients. The AP view reveals an opacity in the left lung extending vertically from the proximal left clavicle to the hilum, approximating the track of the bullet. The left subclavian stripe is obliterated and contiguous with the cap density at the

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apex of the left lung (Fig. 2, 3). Further imaging of the apex by axial CT reveals a dense area similar to the surrounding tissue in the region of expected lung parenchyma. This is consistent with a hemothorax forming an apical pleural cap at the top of the left lung. Para-axial reformat (Fig 4) clearly shows the fluid filled track of the bullet, and densities consistent with hemothorax at the apex, at the dorsal end of the bullet track, and at the dorsal costo-phrenic space.

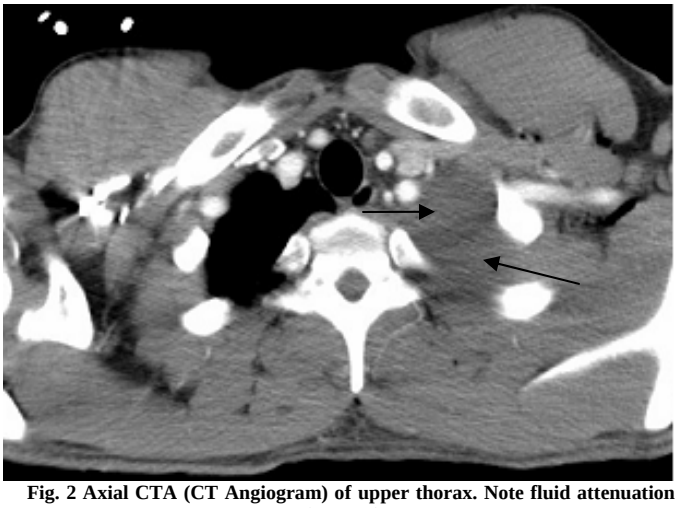

Fig. 2 Axial CTA (CT Angiogram) of upper thorax. Note fluid attenuation in close proximity to the contrast filled left subclavian artery (arrows). This highlights why the left paratracheal stripe is obliterated on the CXR.

Patient Discussion

Injuries of the chest involving the heart, great vessels, and pulmonary hilum are generally fatal. Those involving the lung parenchyma sparing major vasculature can be managed by insertion of a chest tube (tube thoracotomy) and basic wound treatment. Prompt recognition by first responders of tension pneumothorax is the single most important life saving intervention for chest injuries on the battlefield. The cardinal signs of tension pneumothorax include distended neck veins, tracheal shift, decreased breath sounds, hyperresonance of the affected hemithorax, and hypotension. Given the lack of active bleeding in this case, tube thoracotomy provided adequate drainage of the hemothorax. (1). Indications for tube thoracotomy include known or suspected tension pneumothorax, pneumothorax, hemothorax, and any penetrating chest injury requiring transport. For a definitive explanation of the procedure the reader may consult *Emergency War Surgery*, published by the Borden Institute. (1)

After resolution of the hemothorax in the ICU, the patient was transferred in stable condition.

Discussion

6% of wounds in Operation IRAQI FREEDOM and Operation ENDURING FREEDOM were to the thorax (2). Thoracic injuries account for 4% to 15 % of admissions to major trauma centers (3). About 88% to 97% of penetrating injuries to the thorax involve the chest wall, pleura, or lung.(4) Pneumohemothorax occurs in 41% to 45% of symptomatic patients. (5,6)

Isolated pneumothorax or hemothorax diagnosed on admission chest radiography is associated with better outcomes compared to patients with pneumohemothorax, and are less likely to need intercostal tube drainage and less likely to deteriorate clinically. (3)

Gunshot wounds introduce air, hemorrhage, and fragments of bone and bullet into the body that form a telltale track on imaging through the various modalities. (3)

Fig. 3 Axial CTA more inferior also showing fluid near the apex of the left hemithorax (arrows).

This case represents a localized hemothorax and lung contusion. Penetrating trauma introduces air into the pleural space that lessens the pressure differential between outside air and air inside the pleural space. Fluid accumulates from bleeding and also presses on the lung. The result of these changes is decreased lung volume as seen in this case. Factors influencing location of the pneumothorax include patient position, amount of pleural space air, presence of pleural adhesions, and regions of atelectasis. Typically, air in the pleural space collects in the apicolateral aspect of the hemithorax in the erect or semierect patient. (3) Air within the pleural space is diagnosed by visualizing the visceral pleura as a thin sharp line with the absence of lung markings peripheral to this line. Even small pneumothoraces can cause significant respiratory and cardiovascular compromise; especially in patients who already have impaired function. Rhea, et al, indicate that small pneumothoraces are not recognized initially by clinical examination or by admission chest radiography in 30% to 50% of trauma patients, and are only diagnosed after E-FAST (Extended Focused Abdominal Sonography for Trauma) or thoracic CT. (7,8)

In a South African Study it was found that less than 2% of pneumothorax cases and less than 10% of hemothorax cases required surgical intervention. In the case of hemothorax, thoroscopic evacuation of clots was found to be an effective treatment. (4) Hypotensive patients with penetrating chest

injuries should undergo immediate tube thoracostomy with airway control. Open thoracotomy is indicated for massive hemothorax, which is usually defined as 1500cc of output with initial tube thoracotomy or 200cc of output over 4 hours. (1) Surgery is used to manage vascular injury and close the pleural space to outside air.

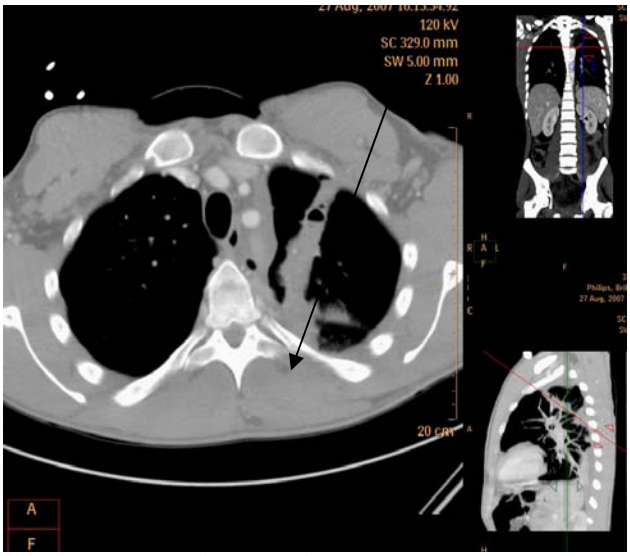

Fig. 4 Para-axial reformation of ballistic trajectory showing small air-fluid level in resultant cavity, contusion and associated hemothorax. The coronal and para-sagittal scout reference images help orient providers to the extent of the missile pathway. Also note the superior to inferior trajectory (red line on para-axial image lower right), and the posterior (dependent) localized hemothorax.

The application of MultiPlanar Reformation in trajectory analysis has been reported recently, and was applied in this case. Knowing that the entrance was anterior, one can further deduce the bullet entered superior to inferior and left to right (initially) for the overall bullet trajectory. (9) See figures 5 and 6 for overall trajectory analysis using MIP, MPR and complex planar reformations.

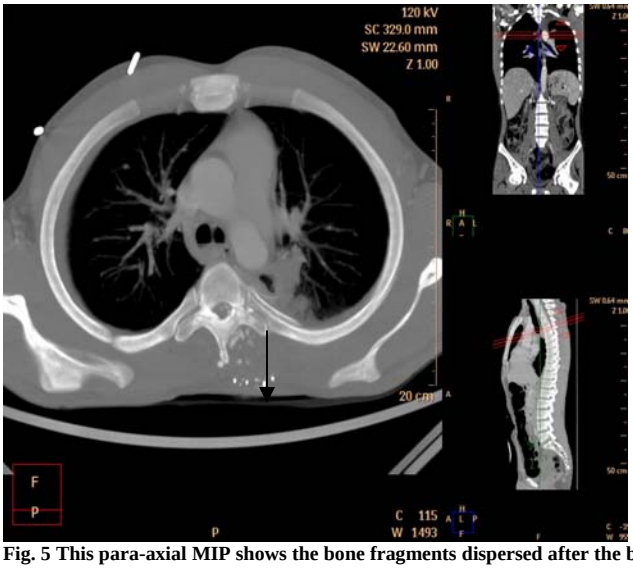

Fig. 5 This para-axial MIP shows the bone fragments dispersed after the bullet hitting lateral aspect of the bony spinal elements. Note rib alignment indicating downsloping para-axial orientation, hence upward deflection of bullet after impact with spine. The arrow shows the ricocheted trajectory.

A quantification scheme called APS (Anatomic Positioning System, or GPS for the body) is currently being researched at our institution. (10) Another case highlights application of this type of trajectory analysis in a grenade injury to the face and neck. (11)

Fig. 6 Para-sagittal reformat along the angled thoracic wound path showing initial downward trajectory (from a sniper, since anterior to posterior, and superior to inferior), until impacting vertebral elements, then ricocheting superiorly (shorter dotted arrow) for a more superior exit than expected. Note the moderate amount of hemothorax dependently.

An example trajectory report could go as follows:
The bullet entered superiorly just below the left clavicle, traveled from left to right towards the midline through the superior left lung, superior to the left pulmonary artery and major branches, impacting T-6 vertebral elements, then deflecting superiorly and strait posterior for a more superior exit, slightly inferior to the entrance.

Category 1 CME or CNE can be obtained on the MedPix™ digital teaching file on similar cases on the following link. Many Radiology Corner articles are also a MedPix™ Case of the Week where CME credits can be obtained.

http://rad.usuhs.mil/amsus.html

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